EXECUTIVE SUMMARY

The Buena Vista Lagoon (Lagoon) is located on the border between the cities of Oceanside and Carlsbad in San Diego County, California. The Lagoon, which is bordered by the Pacific Ocean on the west, Vista Way/Freeway 78 on the north, and Jefferson Street on the east and south, covers an area over 200 acres. Although the majority of the Lagoon is owned and managed by the California Department of Fish and Game (CDFG), other public agencies and private parties own the remaining portions of land. Due to the coastal wetland habitat and number of wildlife species that use the area, including endangered species, the portion of the Lagoon owned by CDFG is designated an Ecological Reserve as described in Title 14, Section 630 of the California Code of Regulations.

The construction of Jefferson Street, Coast Highway, Interstate 5 (I-5), North County Transit District (NCTD) Railroad, and the outlet control weir at the Lagoon inlet, has significantly modified the pre-historical condition of the Lagoon. In addition, urbanization of the Buena Vista Creek Watershed (Watershed) has contributed to modification of the habitat in and around the Lagoon. The existing weir, which was built across the ocean entrance in 1972, controls the minimum water level in the Lagoon, while a naturally occurring beach berm that periodically forms across the mouth of the Lagoon, controls the maximum water level. Since the mid-1970's, the Lagoon has suffered declining water quality, accelerating sedimentation, and diminished biological productivity as a result of urbanization and impacts (e.g., direct fill and circulation reduction) related to the embankments, bridges, and weir constructed within the Lagoon.

In the past, restoration efforts have been constrained by the lack of a comprehensive plan for a sustainable hydrologic system, multiple ownerships within the Lagoon, and conflicting assumptions about what a system should include. The various groups and agencies involved in managing the Lagoon have somewhat differing views on its long-term future. This has been complicated by the fact that little data exists on many of the environmental components necessary to develop a sustainable long-term management plan. For example, sedimentation is commonly acknowledged as a major threat to the ecology of the Lagoon, regardless of the ultimate hydrologic regime (fresh water, brackish water, or salt water). However, there was no sediment quality data available to allow adequate characterization that can be used to accurately predict the fate of the Lagoon sediment (e.g., natural transport to the ocean or dredging and subsequent disposal). The Lagoon bathymetry was last surveyed in 1999, so past efforts to evaluate the long-term sedimentation patterns have relied substantially on comparisons to similar watersheds and coastal lagoons in the area (Applegate 1985, Chang 1986) as well as estimates based on commonly used analytical methods.

The Buena Vista Lagoon Foundation (BVLF) is a non-profit, non-governmental organization dedicated to facilitate management of the unique and sensitive habitats of the Lagoon. The BVLF works to encourage local residents and government officials to develop a sense of stewardship towards the Lagoon for the benefit of future generations. For the reasons above, the BVLF with the concurrence of CDFG decided to undertake a feasibility study to provide the information necessary for the decision makers to determine the ultimate configuration (hydrologic regime) of the Lagoon and the corresponding long-term management plan that will be needed to maintain that configuration.

On behalf of CDFG, the BVLF submitted a grant request to the California State Coastal Conservancy (SCC) to obtain the funds needed to undertake what would become known as the Buena Vista Lagoon Restoration Feasibility Analysis (Study). The BVLF and SCC prepared a list of the analyses needed to provide the information necessary for decision makers to reach a consensus on the alternative configuration (i.e., hydrologic regime, habitat distribution, public access components, and educational features) for the Lagoon. The first phase of the Study, which was funded by mitigation funds from nearby development, consisted of a field program to collect data on the fauna, flora, and water quality of the Lagoon. Completed in 1999, that phase also included a bathymetric survey of the Lagoon and an initial assessment of the geotechnical properties of selected soil proposed as structural fill for the construction of a pedestrian access boardwalk near the Buena Vista Lagoon Audubon Nature Center in Oceanside. The second phase of the Study summarized below builds upon the information obtained during the first phase, with a focus on data analysis, alternative development, and alternative evaluation. The U.S. Fish and Wildlife Service (USFWS) also provided funding during the second phase of the Study for characterization of the Lagoon sediments.

The purpose of the Study is to provide adequate, reliable information to assist the decision makers (i.e., regulatory agencies, resource agencies, affected municipalities, and lagoon land owners) in determining the ultimate configuration of the Lagoon (i.e., hydrologic regime) with input from non-governmental organizations, interested public, and elected officials. The BVLF and SCC retained a multi-disciplinary consulting team to complete the analyses necessary to achieve the Study purpose. The consulting team, headed by Everest International Consultants, Inc. (Everest), characterized existing conditions, identified opportunities and constraints, developed restoration alternatives, analyzed the restoration alternatives, prepared and applied a potential alternative evaluation methodology, and assembled a summary report. This work is summarized below.

EXISTING CONDITIONS

With the exception of a few deep areas, the salinity levels in the soils were very low; hence, indicative of fresh water conditions. The soil within the open water areas of the Lagoon was sampled and found to be relatively free of contaminants. The concentration of contaminants within these areas was low enough to allow consideration of beneficial reuse and disposal options. Chemical testing of soils lying below the cattails and cattail stem and root material also did not reveal the presence of any contamination, thereby indicating that these areas are probably not sequestering contaminants with Lagoon soils. It appears that much of the contamination anticipated to originate from the watershed is being removed in the upstream portions of the Buena Vista Creek, possible in vegetated areas along the streambank. This would need to be verified with an additional study, but the answer is not needed to make a decision regarding the hydrologic regime of the Lagoon at this time. Based on the characterization of the existing soils within the Lagoon, both onsite and offsite beneficial reuse options (e.g., construction fill and beach nourishment) for excavated soil were considered as well as several disposal options (e.g., upland landfill and ocean disposal site).

Three transportation corridors cross the existing Lagoon (I-5, NCTD Railroad, and Coast Highway/Carlsbad Boulevard) to segment the Lagoon into four basins. The ocean outlet weir (Weir) and NCTD Railroad bound the Weir Basin. The Railroad Basin is situated between the NTCD Railroad and Coast Highway. The Coast Highway Basin is located between Coast Highway and I-5. The I-5 Basin is located between I-5 and the mouth of Buena Vista Creek as it enters the Lagoon. Plans are currently under development to improve all three of the transportation corridors. Caltrans is planning to widen I-5 and expand the interchange system between I-5 and Highway 78 to improve capacity. NCTD is planning to add a second track to the railroad corridor that runs through the Lagoon to increase the capacity of the rail system between Los Angeles County and San Diego County. The existing culvert under Coast Highway/Carlsbad Boulevard is inadequate to accommodate storm flows from moderate storm events, thereby limiting flood flow exchange between the Coast Highway Basin and Railroad Basin. In the future, Carlsbad may consider such remedies as increasing the size of the culvert and/or increasing the elevation of roadway. Sedimentation and vegetation in the vicinity of the crossings restricts flows between the four basins (I-5 Basin, Coast High Basin, Railroad Basin, and Weir Basin). There are several utilities (e.g., gas lines, electric lines, communication lines, water pipes, storm drains, and sewer lines) on or near the Lagoon. The functional performance of these infrastructure components must be maintained, mitigated, or replaced as part of the restoration project. In addition, there are some existing easements and agreements between various agencies and utility companies that might pose constraints to restoration, enhancement, and creation of wetlands within the Lagoon.

From an aesthetic standpoint, the Lagoon currently consists of open water and vegetated areas. The open water areas provide pleasant views for many people during the wet season when the open water areas are clear of vegetation. During late spring and early summer, algal blooms cover many open water areas of the Lagoon changing the views from open water to green, brown, and yellow vegetation. This type of view is considered unappealing by many of the people that live around the Lagoon and the people that frequent the Lagoon for recreational purposes. In addition, the heavy reed vegetation choking a large portion of the Lagoon detracts from the open water vistas throughout the entire year. In the past, views of the Lagoon offered an almost uninterrupted view of open water and many local residents would like to see the Lagoon returned to this condition.

There are numerous agencies and organizations involved in overseeing construction, management, and operational activities within the Lagoon. The Lagoon is managed as an ecological reserve by the CDFG, which gives CDFG primary responsibility for overseeing all Lagoon activities. In addition, CDFG is responsible for reviewing activities to make sure that the biological resources of the Lagoon are not impacted adversely. USFWS reviews projects that may adversely affect federally listed wildlife species and the associated habitat while National Marine Fisheries Service provides comments regarding the impacts and benefits of projects on marine fishes and fisheries. Oceanside, Carlsbad, San Diego County, and California Coastal Commission are responsible for issues related to public access, flood protection, and public health. The U.S. Army Corps of Engineers (USACE) regulates dredging activities and activities that might adversely impact navigable waters of the U.S. The Regional Water Quality Control Board is responsible for reviewing activities that would affect the quality of water on the Lagoon. Caltrans, NCTD, Carlsbad, and Oceanside would review any proposed plans to determine potential impacts to transportation infrastructure in the area. CDFG, SCC, Oceanside, and Carlsbad would probably be responsible for reviewing any proposed activities for compliance under the California Environmental Quality Act (CEQA) and the USFWS would probably be responsible for reviewing any proposed activities for compliance under the National Environmental Policy Act (NEPA). Carlsbad, Oceanside, and San Diego County would assess potential impacts to public health related to vector control issues associated with any proposed activities within the Lagoon, while the San Diego Air Pollution Control District would evaluate the impact of activities on air quality. Due to the complex level of overlapping regulations and the need to reach a consensus on the restoration action plan, a technical advisory committee (TAC) was formed that included the agencies mentioned above as well as the other key stakeholders of the Lagoon.

OPPORTUNITIES AND CONSTRAINTS

There are several opportunities to restore the habitat and recreational resources of the Lagoon. The location of the Lagoon at the terminus of the Watershed and adjacent to the Pacific Ocean would allow restoration to a fresh water system or a salt water system. Further, the presence of the existing I-5 transportation corridor and associated bridges could provide a unique opportunity to create a mixed water system with fresh water east of I-5 and salt water west of I-5. The availability of state voter-approved bond funds and increased federal interest in restoring wetlands provide potential sources of funding to improve the water quality of the Lagoon while enhancing recreation and flood storage. Complete or partial restoration of the Lagoon could also be done as part of a project to provide mitigation of impacts to wetland functions and values associated with development projects such as port landfill and residential. The SCC provides additional funding opportunities while continuing its mission of conserving and restoring the State's valuable coastal resources. Carlsbad, Oceanside, and the BVLF provide support and facilitation for the necessary management assistance needed to fulfill the long-term goals and objectives of any restoration project.

While there are several opportunities to restore the Lagoon, there are also several constraints. The relatively high degree of sedimentation within the Lagoon has reduced the potential tidal exchange that could be achieved by removing the weir, thereby opening the Lagoon to tidal influence. This means that, in its present configuration, the Lagoon cannot maintain an open (i.e., stable) ocean inlet/outlet configuration. Therefore, extensive dredging of the Lagoon would be required to improve tidal exchange. The existing Lagoon crossings (I-5 Bridge, Coast Highway Crossing, and Railroad Bridge) and associated transportation right-of-ways pose potential constraints on tidal exchange and flood flow conveyance improvement. This is because modifications to these crossings would be necessary to improve the corresponding hydraulic conveyance efficiency. Since the Lagoon supports numerous natural uses and limited human use, potential environmental impacts to biological and social resources pose a constraint to the implementation of restoration activities within and immediately around the Lagoon.

ALTERNATIVE DEVELOPMENT

Conceptual designs were developed for three restoration alternatives and a no action alternative to a level suitable for subsequent analysis and evaluation. These four alternatives were selected to cover the full range of anticipated alternatives, while optimizing the expenditure of funds on the analysis and evaluation portions of the Study. The three restoration alternative types that were targeted for the Study were: (i) fresh water, (ii) salt water, and (iii) brackish water. The approach used to develop the three restoration alternatives and the no action alternative is presented below.

Restoration Alternatives

A group of goals and objectives were developed for use in preparing an initial set of conceptual restoration alternatives to represent potential habitats that could be achieved under a range of hydrologic regimes spanning from fresh water to salt water. Three unique restoration configurations were developed for each alternative hydrologic regime (i.e., three fresh water, three salt water, and three brackish water). These screening level alternatives were presented to the TAC and public to gain input for the purpose of selecting three restoration alternatives for subsequent analysis and evaluation during the remainder of the study. During the screening process, the brackish water alternatives were eliminated since they would require a salinity gradient across the Lagoon, increasing from Buena Vista Creek towards the ocean and this was deemed undesirable to the TAC and public. However, it was determined that there was some merit in analyzing a mixed water alternative with fresh water to the east of I-5 and salt water to the west of I-5. This resulted in nine potential restoration alternatives (i.e., three fresh water, three salt water, and three mixed water) for future consideration.

The next step was to screen this range down to three restoration alternatives for subsequent analysis and evaluation. This was done by first deciding to select one alternative to represent each of the three hydrologic regimes. This decision effectively placed the emphasis of the Study on differences between hydrologic regimes as opposed to differences between different habitat distributions that could be achieved under each hydrologic regime. The second step was to determine which configuration to select for each of the three hydrologic regimes. This was a challenging task because selection of alternatives with large variations in scope (e.g., earthwork) could bias the outcome of the analysis and evaluation with regards to the focus on hydrologic regime. To address this issue, one new restoration alternative was developed for each hydrologic regime based on similar earthwork and infrastructure activities. This decision allowed the analysis and evaluation to move forward on an "even keel" such that the focus was on differences attributed to the hydrologic regimes as opposed to differences in the amount of earthwork or infrastructure improvement.

The outcome of the alternative development task was the preparation of three restoration alternatives. These three alternatives were presented to the TAC and public to obtain input for subsequent modification of the restoration alternatives prior to initiating the analysis and evaluation effort. The three restoration alternatives were approved by the TAC and public for use in proceeding with the analysis and evaluation. While the three restoration alternatives described below represent the hydrologic regimes that will be advanced through the next phases of the restoration project, upon completion of the Study, these alternatives do not necessarily represent the alternatives that will be analyzed in subsequent phases. Upon completion of the Study, it is envisioned that additional analyses will be conducted to develop an optimal distribution of habitats for the three restoration alternatives for use in selecting a preferred alternative for analysis during the environmental review phase.

Alternative 1 represents the restoration configuration that was used to analyze and evaluate the fresh water hydrologic regime. This alternative achieved the restoration objectives primarily through elimination of the existing reeds and dredging to remove excess sediment. It was assumed that the existing Weir would be replaced with an 80-foot wide ocean outlet weir in accordance with the weir widening project currently being undertaken by Oceanside.

Alternative 2 represents the restoration configuration that was used to analyze and evaluate the salt water hydrologic regime. This alternative achieved the restoration objectives primarily through elimination of the existing reeds, dredging to remove excess sediment, and establishment of continuous tidal exchange.

Alternative 3 represents the restoration configuration that was used to analyze and evaluate the mixed water hydrologic regime. This alternative achieved the restoration objectives primarily through elimination of the existing reeds, dredging to remove excess sediment, establishment of continuous tidal exchange for the western portion of the Lagoon, and relocation of the weir to I-5 to maintain a fresh water regime east of I-5.

One of the primary objectives of the restoration project is to improve circulation within the Lagoon by improving tidal exchange between the Lagoon and ocean. The degree of tidal exchange is controlled by the hydraulic connection (i.e., ocean inlet/outlet) between the Lagoon and ocean as well as the hydraulic connections (i.e., Lagoon crossings) between the four basins. There are numerous combinations of potential improvements that could be made to the three Lagoon crossings. Each of these combinations would affect the degree of tidal exchange and, consequently, the ultimate habitat distribution for a given grading configuration. To address this issue within the scope of the Study, three configurations (i.e., scenarios) for the three Lagoon crossings were developed to allow an analysis of the Salt Water Alternative (Alternative 2) and Mixed Water Alternative (Alternative 3) across a range of likely hydraulic connections between the four basins.

No Action Alternative

A no action alternative was developed to provide some insight into the potential habitat distribution and appearance of the Lagoon in the future if no restoration of the Lagoon is undertaken. A timeframe of 50 years was selected as this period of time is frequently used in engineering design and economic analyses and provides a consistent basis of comparison for the restoration alternatives. Although it is likely that continued deterioration of the Lagoon will occur over this timeframe and organizations would probably respond to this deterioration with some type of activity, it was assumed that no human intervention would be undertaken in the absence of the restoration project. This assumption provides a way to address the fundamental question of what would happen to the Lagoon if nothing is done and future environmental forcing factors (e.g., rainfall, sedimentation, and pollutant loads) are similar to the past.

Based on analyses conducted as part of the Study, it was estimated that within approximately thirteen years the I-5 Basin will reach capacity and begin passing nearly 100% of the sediment through to the Coast Highway Basin and beyond. The Coast Highway Basin will continue to fill and pass larger and larger portions of the sediment on to the Railroad Basin and Weir Basins as time progresses. The Railroad Basin and Weir Basin will reach capacity prior to the Coast Highway Basins, such that by about year 30 all sediment entering the Lagoon will be passed through to the beach and ocean. In addition to the degree of sedimentation within the Lagoon resulting from upstream inputs, long-term evolution of the existing vegetated areas (e.g., cattail areas) in the future will depend on the expansion and contraction of these areas due to vegetative processes. This process was assessed through an analysis of historical vegetation growth rates and patterns. The analysis indicated it is likely that all of the existing open water area, except for a small flow channel, will evolve to vegetated habitat within the next 50 years.

The large degree of variability in sedimentation patterns attributed to differences in sediment grain size distribution and creek flows was assessed by developing two scenarios for Lagoon evolution. These two scenarios also represent a likely range of habitat endpoints that could form over the next 50 years. The first scenario was based on the assumption that the sediment grain size distribution of future upstream sediment deliveries to the Lagoon will be homogeneous, thereby yielding a relatively uniform settlement of sediment across the Lagoon. Under this scenario, an essentially monotypic stand of fresh water marsh with a flow channel of open water and a slight fringe of upland vegetation would develop. The second scenario was based on the assumption that the sediment grain size distribution of future upstream sediment deliveries to the Lagoon will be heterogeneous, thereby yielding highly variable temporal and spatial settlement of sediment across the Lagoon. This would result in a more diverse mix of wetland habitats, as large storm events place sediment in elevated bars producing more complex topography and ultimately leading to the development of meadow and riparian forest communities.

Evolution of the Lagoon after filling of the open water areas is highly dependent on future fluvial sediment consistency, vegetation trapping efficiencies, and basin topography. Because these factors are anticipated to continuously evolve over time and would also be highly dependent on storm magnitude and frequency, the extent and pattern of evolution that will occur by year 50 is not fully discernable. However, the final configuration of the Lagoon is not as important as the fact that the two scenarios likely bracket the range of potential habitats and appearances that are likely over the next 50 years. Moreover, the results indicated that the Lagoon will evolve to non-wetlands habitat in the next 30 years to 50 years in the absence of a restoration project. Since a primary goal of all the stakeholders is to maintain the Lagoon as wetlands habitat of some type (i.e., fresh water, salt water, or mixed water), no additional analyses were conducted for the No Action Alternative nor was it evaluated for comparison with the three restoration alternatives.

ALTERNATIVE ANALYSES

A series of analyses was conducted for the three restoration alternatives to provide the information needed to evaluate the alternatives. The analyses included an assessment of the key physical processes, biological/ecological components, and socioeconomic factors of each alternative. Since the primary purpose of the subsequent evaluation was to provide the information needed for decision makers to select the preferred hydrologic regime of the Lagoon, the analyses focused on elements that allowed delineation between these regimes. The following analyses were conducted for the restoration alternatives and, where needed to provide a baseline for comparison, some of these analyses were also conducted for existing conditions.

Physical Processes

- Watershed loading
- Tidal inlet stability
- Lagoon hydrodynamics
- Lagoon salinity
- Lagoon sedimentation

Biological/Ecological Components

- Habitat distribution
- Habitat evaluation assessment

Socioeconomic Factors

- Construction costs
- Cost effectiveness
- Maintenance costs
- Potential environmental impacts
- Vector control

Watershed loading analyses were conducted to estimate the inputs of pollutant, sediment, and fresh water flows into the Lagoon. The sediment loads were used to estimate the rate of Lagoon sedimentation attributed to upstream sediment inputs for subsequent use in developing a range in potential maintenance dredging costs. An analysis was performed to identify the pollutant sources and corresponding loads associated with the critical pollutants within the Watershed that impact the Lagoon. The fresh water flow inputs were used to assess the impacts of the alternatives on Lagoon flooding and to estimate the salinity regime of the Lagoon.

The stability of the proposed tidal inlet under Alternatives 2 and 3 was analyzed to determine the cross-sectional area of the tidal inlet and to assess the need for stabilization structures such as jetties. The stable cross-sectional area of the tidal inlet was estimated using established methods that relate the stable cross-sectional inlet area to the volume of water that flows through the inlet on a daily basis. The inlet cross-sectional area was used as input to a Lagoon model to determine the water elevation and velocity response to tides. This information was then used to determine if the Lagoon hydrology was suitable for achieving the desired habitat distribution. An iterative process involving modifications of the inlet cross-sectional area, grading plan, and habitat distribution was conducted until the desired habitat distribution was achieved.

Modeling of the Lagoon was conducted to simulate flow conditions under each alternative. The lagoon modeling involved simulating water elevation changes, flows, and salinity concentrations with several models. A combination of models was used to optimize the strengths and minimize the weaknesses of the different types of models so that no computation time was wasted by utilizing more advanced methods than necessary to address each issue. These models were used to assess the effects of the different grading plans and modifications to the Lagoon crossings on tidal exchange and flood flows. The results indicated that the Lagoon crossings are the critical choke points within the Lagoon system relative to tidal exchange between the ocean and Lagoon. A stable ocean inlet/outlet cross-section would be able to restore an adequate tidal prism to the Lagoon for the purpose of restoring salt water marsh habitat. The Railroad Bridge causes the greatest degree of tidal muting, while the I-5 Bridge causes the least tidal muting. This means that the greatest marginal improvement in tidal exchange would be achieved through progressive modification of the hydraulic connections as follows: (a) ocean inlet/outlet, (b) Railroad Bridge, (c) Coast Highway Crossing, and (d) I-5 Bridge.

The results of the flood analyses revealed that Alternatives 2 and 3 would improve the flooding conditions throughout all four basins of the Lagoon. The greatest benefit would occur in the I-5 Basin with less benefit moving west towards the ocean. Alternative 1 would improve flooding conditions in the I-5 Basin but it could lead to higher flood levels in the Coast Highway Basin, Railroad Basin, and Weir Basin. This is because the improved hydraulics attributed to vegetation clearing and sediment removal would allow flood flows that currently back up in the I-5 Basin to pass more readily into the other three basins. It was beyond the scope of the Study to determine the significance of this potential impact as a detailed hydraulic study using methods approved by the appropriate flood management agencies (e.g., San Diego County and Federal Emergency Management Agency) would be needed to address this potential issue.

The fresh water flows entering the Lagoon from Buena Vista Creek will decrease salinity levels in the Lagoon under the restoration alternatives involving the restoration of tidal exchange (i.e., Alternatives 2 and 3). Substantial decreases of an extended duration in salinity levels below marine salinity levels can adversely affect marine organisms. To address this potential impact to the marine species expected to use the Lagoon under Alternatives 2 and 3, a salinity analysis was conducted. The results of the salinity analysis revealed that the value of the salt water fish habitat within the Lagoon would be somewhat impaired for marine fish due to upstream fresh water inputs. Salinity variations of the magnitude estimated for this analysis are normal for southern California estuaries and the marine organisms are adapted to this variation. However, the implication is that fresh water might limit the potential use of the Lagoon as mitigation for port landfill projects. This is because these types of mitigation projects usually require the creation and maintenance of a stable marine water environment.

An analysis was undertaken to estimate the sedimentation rates within the Lagoon associated with both fluvial and littoral sediment sources. Fluvial sedimentation rate estimates were developed through an analysis of the sediment that enters the Lagoon from Buena Vista Creek primarily during flood events. These rates were developed for all three restoration alternatives to estimate the magnitude and frequency of dredging required to maintain the alternative grading configurations as well as to minimize habitat impacts associated with fluvial sedimentation.

An analysis of the ocean inlet/outlet ebb bar and flood bar morphology was conducted to estimate the rates of littoral sedimentation within the Lagoon. Littoral sedimentation rates were developed for Alternatives 2 and 3 to estimate the magnitude and frequency of dredging required to maintain the alternative grading configurations and to minimize habitat impacts associated with littoral sedimentation. Since there is no tidal connection between the ocean and Lagoon under Alternative 1, sedimentation rates attributed to littoral sediment were not developed for this alternative. Sedimentation information from other southern California lagoons was incorporated into the analyses used in estimating littoral sedimentation rates to bracket the potential variability of this important factor.

The results of the sedimentation analyses were used to estimate average annual maintenance dredging rates for the four basins, which are presented in Table ES-1. The values in Table ES-1 represent average annual dredging rates; however, actual dredging events will occur when the level of sedimentation starts to adversely affect the habitat within the Lagoon and this information is presented in Chapter 6 of the report.

Table ES-1 Annual Maintenance Dredging Requirement

		MAINTENANCE DREDGING VOLUME (CY/YEAR)		
		ALT 1 FRESH WATER	ALT 2 SALT WATER	ALT 3 MIXED WATER
Fluvial Sediment				
I-5 Basin	Min	28,900	29,000	28,900
	Max	28,900	29,400	31,700
Coast Highway Basin	Min	0	4,600	2,900
	Max	0	4,600	4,300
Total Volume	Min	28,900	33,600	31,800
	Max	28,900	34,000	36,000
Littoral Sediment				
Railroad Basin & Weir Basin	Min	0	45,600	45,600
	Max	0	63,600	63,600

A habitat evaluation was performed to develop quantitative measures of the value of the various habitat types created under each alternative, with consideration for the number of species and their relative abundance. The results of a habitat evaluation form one component for the comparison of various restoration alternatives and, when used in combination with other biological factors (e.g., habitat scarcity, regional needs, and impacts to existing habitat/wildlife) as well as sociological factors (e.g., aesthetic impacts, human health impacts, and meeting restoration goals/objectives), provide the basis for a thorough evaluation of restoration alternatives. The existing fresh water condition of the Lagoon makes it a unique coastal wetland resource within southern California. This unique aspect makes it difficult to apply standard procedures for habitat evaluation because the comparison cuts across different ecosystems; therefore, a habitat evaluation approach was developed specifically for the Study. The calculation of overall habitat units was conducted by applying the evaluation to existing conditions and the three restoration alternatives. The results indicated that the salt water regime had the highest habitat value due to the abundance of valuable shallow salt water, eelgrass, and mudflat habitats, despite the “penalty” associated with a greater acreage of upland habitat. The mixed water alternative (Alternative 3) had the next highest habitat value followed by the fresh water alternative (Alternative 1). The existing Lagoon had the lowest habitat value of the alternatives analyzed using the evaluation approach. The number of net habitat units (i.e., over existing conditions) created for each restoration alternative was 13.1, 46.6, and 36.8 for Alternative 1, Alternative 2, and Alternative 3, respectively.

The cost to construct the restoration alternatives is a key consideration in selecting the preferred hydrologic regime. The most significant construction components of the Lagoon restoration project would be dredging to remove sediment from the Lagoon and the subsequent disposal of the dredged material. Other costs would include exotics removal, planting, and infrastructure modification (e.g., highway and railroad bridges, culverts and inlet). It was assumed that all beach suitable material would be placed on beaches in the immediate vicinity of the Lagoon. Unit costs were developed for the numerous disposal options identified as part of the sediment characterization program and were used in preparing construction and maintenance estimates. The construction costs ranged from $37.3 million to $98.3 million, $39.9 million to $116.1 million, and $40.6 million to $109.1 million for Alternatives 1, 2, and 3, respectively. The variation in costs for each alternative is attributed to differences in sediment disposal costs and infrastructure modifications and improvements. Balanced evaluations across the alternatives can only be made by comparing either the lower estimates or higher estimates with one another.

An assessment of the cost effectiveness of the three restoration alternatives was performed to help make decisions regarding the best use of project funds to achieve biological and ecological improvements in the Lagoon. The cost effectiveness methodology is typically utilized by federal agencies (e.g., USACE) to determine the various restoration measures (e.g., tidal exchange maintenance and exotics removal) that yield the most benefits to the ecosystem for the least cost. To estimate the cost effectiveness of the restoration alternatives the maximum construction cost of each alternative was divided by the net increase in habitat units (HU) associated with implementation of each alternative. The results were $7.5 million per HU, $2.5 million per HU, and $3.0 million per HU for Alternatives 1, 2, and 3, respectively.

The frequency, cost, and potential impacts associated with maintenance activities of the Lagoon under various alternatives are primary considerations in selecting the preferred hydrologic regime. The most significant components of Lagoon maintenance would be dredging to remove sediment from upstream and coastal sources. Other components would be those associated with habitat and wildlife maintenance, include habitat management, trash removal, public access control, predator control, exotics removal and revegetation to maintain the target plant communities for the three restoration alternatives. The quantities and costs of these maintenance activities were estimated and this information was used to develop a range of maintenance costs (minimum and maximum). The variation in maintenance costs depends on several factors, including the volumes and frequencies of required dredging and the unit costs and needs of various maintenance components. The annual maintenance costs were estimated to range from $0.5 million to $1.4 million, $0.9 million to $2.2 million, and $0.9 million to $2.3 million for Alternative 1, Alternative 2, and Alternative 3, respectively. The primary difference between the fresh water and salt water maintenance costs is the additional cost associated with littoral sediment dredging under the salt water and mixed water alternatives.

A summary of the net habitat units created under each alternative is provided in Table ES-2, along with cost estimates for construction and maintenance. In addition, the table includes estimates of the cost-effectiveness expressed in units of dollars per net habitat unit created ($/HU). The costs presented in Table ES-2 are based on the maximum costs estimated for construction and maintenance.

Table ES-2 Alternative Comparison

	FRESH WATER ALTERNATIVE	SALT WATER ALTERNATIVE	MIXED WATER ALTERNATIVE
Construction cost	$98.3 Million	$116.1 Million	$109.1 Million
Net restored habitat value	13.1	46.6	36.8
Cost effectiveness	$7.5 Million/HU	$2.5 Million/HU	$3.0 Million/HU
Annual maintenance cost	$1.42 Million/yr	$2.27 Million/yr	$2.35 Million/yr

EVALUATION

The primary types of information required for the decision makers to evaluate the three restoration alternatives and select the preferred hydrologic regime were determined from the initial study objectives and input provided by the TAC and interested public during the Study process. This input came in the form of recommendations and issues that were raised during TAC and public meetings. This information was used to develop a potential evaluation process for use by the decision makers that was based on a consideration of screening level assessments of numeric, semi-quantitative, and qualitative objectives, along with the projected ability of each alternative to fulfill overall restoration project objectives. This type of evaluation would include consideration of ecological/biological factors as well as non-biological considerations (e.g., construction costs, vector control, maintenance costs, and potential environmental impacts). The ecological/biological factors would include habitat value; impacts to birds, fish, special status species, and existing habitat and wildlife; and export of productivity to the coastal zone. The non-biological factors would include circulation, vector control, construction costs; cost effectiveness, construction-related impacts to social resources, and maintenance costs. This process was developed for potential use by identifying metrics for each of these factors to gauge the relative performance of one alternative compared to the others. In order to help with evaluation of the restoration alternatives, these metrics could be considered in conjunction with qualitative judgments regarding potential impacts to bridges, flooding, water quality, cultural resources, recreation, public health, and visual resources, as well as consideration for the preferences of the local community. A summary of the evaluation factors mentioned above is shown in Table ES-3 for each of the three restoration alternatives. Included in the table are potential comparative metrics that could be adopted for each factor.

Table ES-3 Alternative Evaluation Summary Matrix

EVALUATION FACTOR	FRESH WATER ALTERNATIVE	SALT WATER ALTERNATIVE	MIXED WATER ALTERNATIVE	POSSIBLE COMPARATIVE METRIC
Minimize construction impacts to existing habitat and wildlife	91.0 impacted acres	226.0 impacted acres	148.0 impacted acres	Best = Fewest number of acres impacted during construction
Maximize benefit to fish species	0.56	1.00	0.77	Best = Maximum number of fish species by habitat with an area of available habitat normalized relative to the maximum value (1.00 max)
Maximize benefit to bird species	0.81	1.00	0.94	Best = Maximum number of bird species by habitat with an area of available habitat normalized relative to the maximum value (1.00 max)
Maximize benefit to special status species	0.85	1.00	0.98	Best = Maximum number of special status species by habitat with an area of available habitat normalized to the maximum value (1.00 max)
Maximize water circulation and productivity export to coastal zone	0.0 acres	180.0 acres	118.0 acres	Best = Maximum area under tidal influence (acres)
Minimize potential habitat for vectors (e.g., mosquitoes)	0.0 tidal Acres	180.0 tidal acres	118.0 tidal acres	Best = Maximum area of tidal habitat area (acres)
Minimize construction cost *	$98.3 Million	$116.1 Million	$109.1 Million	Best = Lowest construction cost ($)
Maximize net restored habitat value	13.1	46.6	36.8	Best = Highest number of net habitat units (HU) based on combined values for fish, birds, and special status species
Maximize cost effectiveness	$7.5 Million/HU	$2.5 Million/HU	$3.0 Million/HU	Best = Lowest cost per net habitat unit ($/HU)

Table ES-3 Alternative Evaluation Summary Matrix (Cont.)

EVALUATION FACTOR	FRESH WATER ALTERNATIVE	SALT WATER ALTERNATIVE	MIXED WATER ALTERNATIVE	POSSIBLE COMPARATIVE METRIC
Minimize short-term construction related impacts to social resources (e.g., transportation and noise)	1,845,000 yd^3	1,805,000 yd^3	1,825,000 yd^3	Best = Lowest net excavation volume to be disposed of and/or reused (yd^3)
Minimize annual maintenance cost **	$1.42 Million/yr	$2.27 Million/yr	$2.35 Million/yr	Best = Lowest annual cost ($/yr)

* *The construction cost for each alternative is the highest cost estimated based on the most costly disposal option and the most expensive habitat configuration, including infrastructure modifications and revegetation. The scenario with the highest construction cost for each alternative is listed below.*

- *Salt Water Alternative: Scenario 2 with Off-Site Landfill Disposal Option; infrastructure modifications include replacement of I-5 Bridge, Coast Highway Crossing, NCTD Railroad Bridge.*
- *Mixed Water Alternative: Scenario 2 with Off-site Landfill Disposal Option; infrastructure modifications including replacement of Coast Highway Crossing and NCTD Railroad Bridge, relocation of weir.*
- *Fresh Water Alternative: Off-site Landfill Disposal Option; no bridge modifications are required.*

** *Annual maintenance cost for each alternative represents the highest cost estimate based on the highest estimated sedimentation rates and the highest unit disposal cost of the dredged sediment (upland landfill).*

Fresh Water Alternative (Alternative 1)

The Fresh Water Alternative (Alternative 1) had lower habitat-normalized values for fish, bird, and threatened and endangered species, although these values do not correspond directly to community similarities or differences and it is important to consider which habitat and community endpoints are most desirable so that decisions are not based solely on numeric comparisons. Construction impacts to existing biota and habitats were lowest while short-term impacts to social resources were somewhat higher, based on dredging volumes, than for the other regimes. Construction and maintenance costs were lowest, but cost effectiveness per net habitat unit was low. Permitting and mitigation costs also are likely to be lower. Vector control potential (i.e., potential to control mosquitoes) based on natural conditions (fresh water) was lowest, as was water circulation. Potential impacts to social resources such as infrastructure and visual were the least, while there were either no impacts or no differences in impacts compared to the other regimes for numerous other resources, including water quality, cultural, and some infrastructure and visual elements. The local public expressed a strong preference for the fresh water hydrologic regime and specific features that elicited some of the strongest responses included a preference for predominantly open water, predominantly waterfowl habitat, and nesting sites for birds as well as a dislike for public trails.

Salt Water Alternative (Alternative 2)

Salt Water Alternative (Alternative 2) results were generally opposite of those for the Fresh Water Alternative (Alternative 1). Salt Water had higher habitat-normalized values for fish, bird, and threatened and endangered species, although as noted above these values do not correspond directly to community similarities or differences and it is important to consider which habitat and community endpoints are most desirable. Construction impacts to existing biota and habitats were highest while short-term impacts to social resources were somewhat lower, based on dredging volumes, than for the other regimes. Permitting and mitigation costs also are likely to be higher. Construction and maintenance costs were highest, but cost effectiveness per net habitat unit was also the highest. Vector control potential based on natural conditions (salt water) was highest, as was water circulation. Potential impacts to social resources such as infrastructure and visual were the most, as were potential impacts to public health and safety measures such as hazards from increased tidal currents and reduced lateral beach access near the ocean inlet/outlet. As noted for Fresh Water there were no differences in impacts compared to the other regimes for several other resources, including water quality, cultural, and some infrastructure and visual elements. The local public indicated the lowest preference for salt water compared to fresh water and mixed water and specific features that elicited some of the strongest responses included a preference for predominantly open water and a dislike of predominantly salt marsh and mudflat habitats.

Mixed Water Alternative (Alternative 3)

Mixed Water Alternative (Alternative 3) results fell predominantly between those for the Fresh Water (Alternative 1) and Salt Water Alternatives (Alternative 2), but generally were more similar to Salt Water. The exception is slightly higher maintenance costs than for Salt Water. The local public indicated a preference for mixed water somewhere between fresh water and salt water but much closer to salt water. Specific features under a mixed water regime that elicited some of the strongest responses included a preference for predominantly open water and a dislike of predominantly salt marsh and mudflat habitats, as noted for salt water.

CONCLUSIONS

Buena Vista Lagoon currently provides important benefits to wildlife and humans. The Lagoon provides habitat for plant, fish, birds, and invertebrate species, including several special status species. The Lagoon represents the only local fresh, open water marsh system managed by the CDFG as an ecological reserve making it an important part of the biological resource composition of the State. The Lagoon serves also as a flood basin and flood conveyance facility to store and transfer upstream flows and local runoff to the ocean through a weir that was installed in 1972. Recreational and educational opportunities related to wildlife viewing and environmental stewardship are also provided by the Lagoon waters and surrounding areas. In addition, the Lagoon provides an important visual resource offering uninterrupted vistas of open water, coastal bluffs, and the Pacific Ocean similar to other lagoons in Southern California.

The Lagoon has been changing steadily over time with progressive degradation of the various benefits to wildlife and humans. Sedimentation attributed to upstream watershed sources has resulted in the loss of wetland and open water habitat. The sedimentation combined with the fresh water hydrologic system as resulted in the formation of a monostand of cattail and bulrush vegetation. Results from the present and recent studies indicated that the Lagoon would most likely become vegetated fresh water marsh or riparian woodland within the next 30 to 50 years, thereby ceasing to provide wetland functions and values. This continued degradation would also likely result in increased vector problems, additional water quality impairments, and impacts to visual resources provided by the Lagoon.

The hydrologic, hydraulic, and sediment transport processes of the Buena Vista Creek Watershed are typical of those for similar watersheds in southern California with one exception: the level of contamination in Lagoon soils is lower than normally observed in similar urban portions of southern California. This means that the delivery of fresh water from the Watershed and loading of contaminants associated with local runoff and urban inputs entering the Lagoon is within ranges commonly observed in the region. In addition, the existing coastal processes at work in the vicinity of the Lagoon are similar to those found at other coastal wetlands in North San Diego County (e.g., Batiquitos Lagoon, Agua

Hedionda Lagoon, San Dieguito Lagoon, and San Elijo Lagoon). The wave conditions, tides, seasonal beach width fluctuations, volume rates of sand moving along the coast, and long-term shoreline fluctuations are within the ranges documented for these other southern California lagoons. This includes the presence of cobbles on the beach face as observed at Batiquitos Lagoon and San Elijo Lagoon in Carlsbad and Encinitas, respectively.

From an engineering and ecological standpoint, the results of the study indicate that it is feasible to restore the Lagoon to a fresh water, salt water, or mixed water hydrologic regime. The excavation/dredging and subsequent disposal and reuse of soils utilizing the sediment management options identified in this study have been used or approved for use in other southern California coastal wetland restoration projects such as Batiquitos Lagoon (overdredged pit and beach nourishment), San Dieguito Lagoon (upland fill, beach nourishment, onsite placement), Anaheim Bay Mitigation Project (upland fill and onsite placement) and Bolsa Chica Wetlands Restoration (beach nourishment, nearshore placement, landfill, and onsite placement). Ocean inlet/outlet stabilization structures (e.g., jetties) have been constructed or approved for construction at Batiquitos Lagoon and Bolsa Chica Wetlands, while inlet sedimentation management plans have been implemented and proposed as part of restoration projects at San Dieguito Lagoon and San Elijo Lagoon. Infrastructure improvements including bridge modifications, slope protection, and utility protection/realignment were completed for Batiquitos Lagoon and are currently proposed for Bolsa Chica Wetlands and San Dieguito Lagoon, along with maintenance dredging programs. Although there are no examples of the conversion of a fresh water wetland system to a salt water wetland system in southern California, the implementation of previously approved restoration projects has involved substantial modifications to the hydrologic regime of different systems (e.g., brackish and hypersaline to salt water).

Since it would be possible to restore the Lagoon from an engineering and ecological standpoint, the question of feasibility should be based on achieving the best balance between impacts to existing resources and costs compared with benefits to wildlife and humans. Primary factors that should be considered to achieve a balance in an evaluation of the three hydrologic regimes are the potential environmental impacts associated with project implementation; benefits to fish, birds, and special status species; overall increase in habitat value over existing conditions; construction costs; and maintenance costs. In addition, the preferences of the local public regarding the hydrologic regime and habitat distribution will be an important factor in selecting the preferred alternative.

The results of this Study revealed that a fresh water regime would have lower benefits to fish, bird, and special status species than a salt water regime or mixed water regime. Construction impacts to existing biological resources would be lower while short-term impacts to social resources would be somewhat higher than a salt water regime or mixed water regime. Construction and maintenance costs for a fresh water regime would be lower than the other two regimes, but cost effectiveness per net habitat unit created would also be the lowest. Vector control and water circulation are likely to be relatively poor under a fresh water regime in comparison to a salt water regime and mixed water regime. Potential impacts to infrastructure and visual resources would be less for the fresh water regime compared to the other two regimes.

In comparison, a salt water regime would have higher benefits to fish, bird, and special status species than a fresh water regime or mixed water regime. Construction impacts to existing biological resources would be higher while short-term impacts to social resources would be somewhat lower than a fresh water regime or mixed water regime. Construction costs for a salt water regime would be higher than the other two regimes, but cost effectiveness per net habitat unit created would also be the highest. Maintenance costs are higher for the salt water regime compared to the fresh water regime, but are slightly lower than the mixed water regime. Vector control and water circulation are likely to be relatively good under a salt water regime in comparison to a fresh water regime and mixed water regime. Potential impacts to infrastructure and visual resources would be the greatest for the salt water regime compared to the other two regimes, as well as impacts to public safety due to the creation of an ocean inlet/outlet and the associated increases in tidal current and reductions in lateral beach access.

Results of the Study indicated that a mixed water regime would have impacts, costs, and benefits that fall predominantly between those for the fresh water and salt water regimes, but generally were more similar to the salt water regime. The exception is that the mixed water regime would have a slightly higher maintenance cost than the salt water regime.

The ultimate decision of whether to restore the Lagoon to a fresh water, salt water, or mixed water regime will depend on the relative importance that the various decision makers place on the evaluation factors presented in this report. Each agency and organization will utilize the information in this report to render a recommendation on the preferred hydrologic regime based on the balance between benefits, impacts, and costs relative to their mission, goals, and objectives. This much is certain, if the existing physical, biological, and chemical processes at work within and around the Lagoon are not altered then the wetland habitat functions and values of the Lagoon will continue to degrade in the future, along with the benefits that the Lagoon provides to wildlife and humans. Actions have been taken in the watershed to improve the quality of water entering the Lagoon and around the Lagoon to discourage activities that degrade habitat. It is now time to take action in the Lagoon for the benefit of wildlife and future generations of humans that utilize the Lagoon. This report provides the information needed for the decision makers to select the preferred hydrologic regime for the Lagoon, such that preliminary engineering and environmental review can proceed in an objective, balanced manner.